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MX28B200/400
-48 VDC POWER SYSTEMS
User's Manual

(Document # 990-9133)

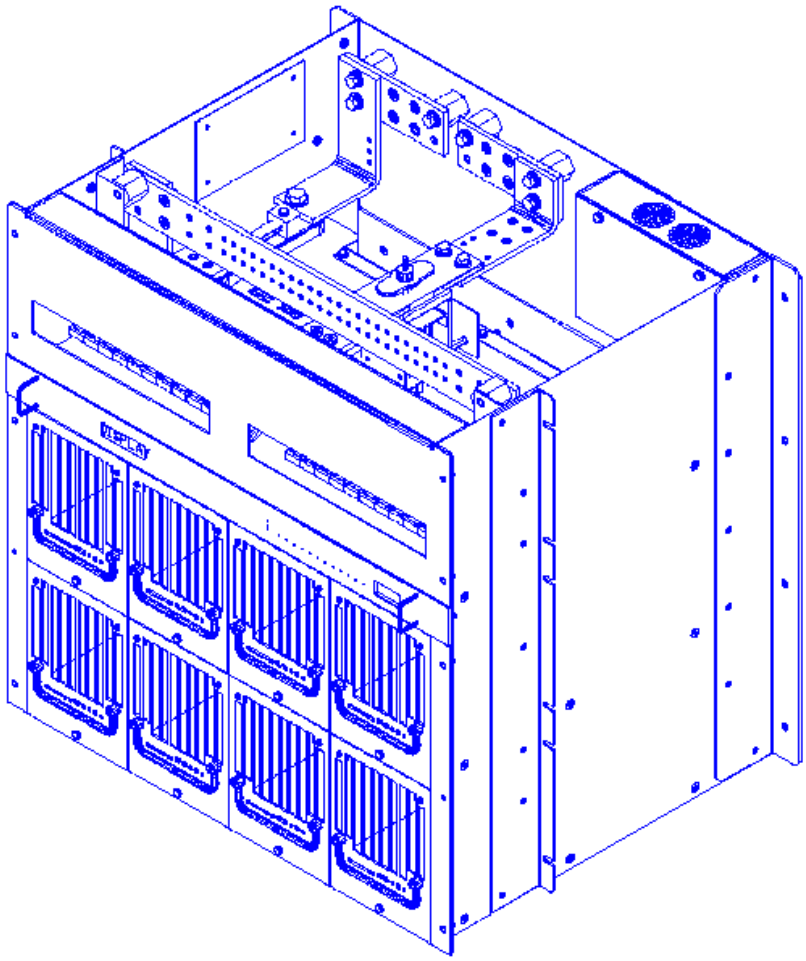


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Revision History

Revision	Date	By	Description
1	31 JAN, 2002	JNF	Converted to APC numbering
2	17 MAY, 2002	BET	Updated Format

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1 Safety First!

It is very important to follow all safety procedures when unpacking, installing and operating any sort of power equipment.

1.1. Warning Symbols

	**CAUTION**: An indication that special care is required to prevent injury, equipment damage or misuse

	**WARNING**: An indication of an electrical hazard that may cause serious personal injury or death, catastrophic equipment damage or site destruction..

1.2. General Precautions:

	**WARNING**: The DC power plant is supplied from a nominal 220VAC, 50/60 Hz source. Keep the AC input enclosure cover in place when the system is operational or energized

	**WARNING**: Hazardous energy levels are present on bare conductors in the -48VDC distribution connection area of the plant. Accidental shorting of distribution conductors can cause arcing and high currents that can cause serious burns or other physical harm. It is recommended that: • Any jewelry, rings or watches be removed while working on this equipment. • Handles of all wrenches, screwdrivers, cutters and pliers are insulated. • Shafts of screwdrivers are wrapped in electrical tape or otherwise insulated

	**WARNING**: Ensure that all of the DC and external AC circuit breakers are in the OFF position prior to connecting service to the power plant. Confirm that all voltages have been removed including any battery sources before proceeding**.**

Specific **CAUTION** and **WARNING** will be placed in manual where appropriate
.

2 Introduction

2.1. General Information

DC Power Plants from APC have unique features that make them easy to install, maintain, and upgrade. The rectifier units are modular and truly “hot-pluggable” into the shelf assembly without any separate AC wiring. All system settings are made from the system control unit that provides monitoring and control functions for each component of the system as well as alarm listings for system diagnosis and maintenance.

The APC Model MX28B is a modular stand-alone -48V DC power plant. It is configurable in such a manner that it will support most typical applications within the specified current ranges (either 200 or 400 amperes) without special application engineering or assistance. Distribution is included for up to 24 plug-in circuit breakers. These circuit breakers can be 1 to 100 amps, with 60-100 amp breakers requiring two positions and a circuit breaker adapter kit. An optional low voltage disconnect (LVD) can be provided on either the battery or the load side. A 400 amp MX28B is shown in Figure 2.1-1 MX28B-400 –48 VDC Power Plant. A block diagram is shown in Figure 2.1–1.



Figure 2.1-1 MX28B-400 –48 VDC Power Plant

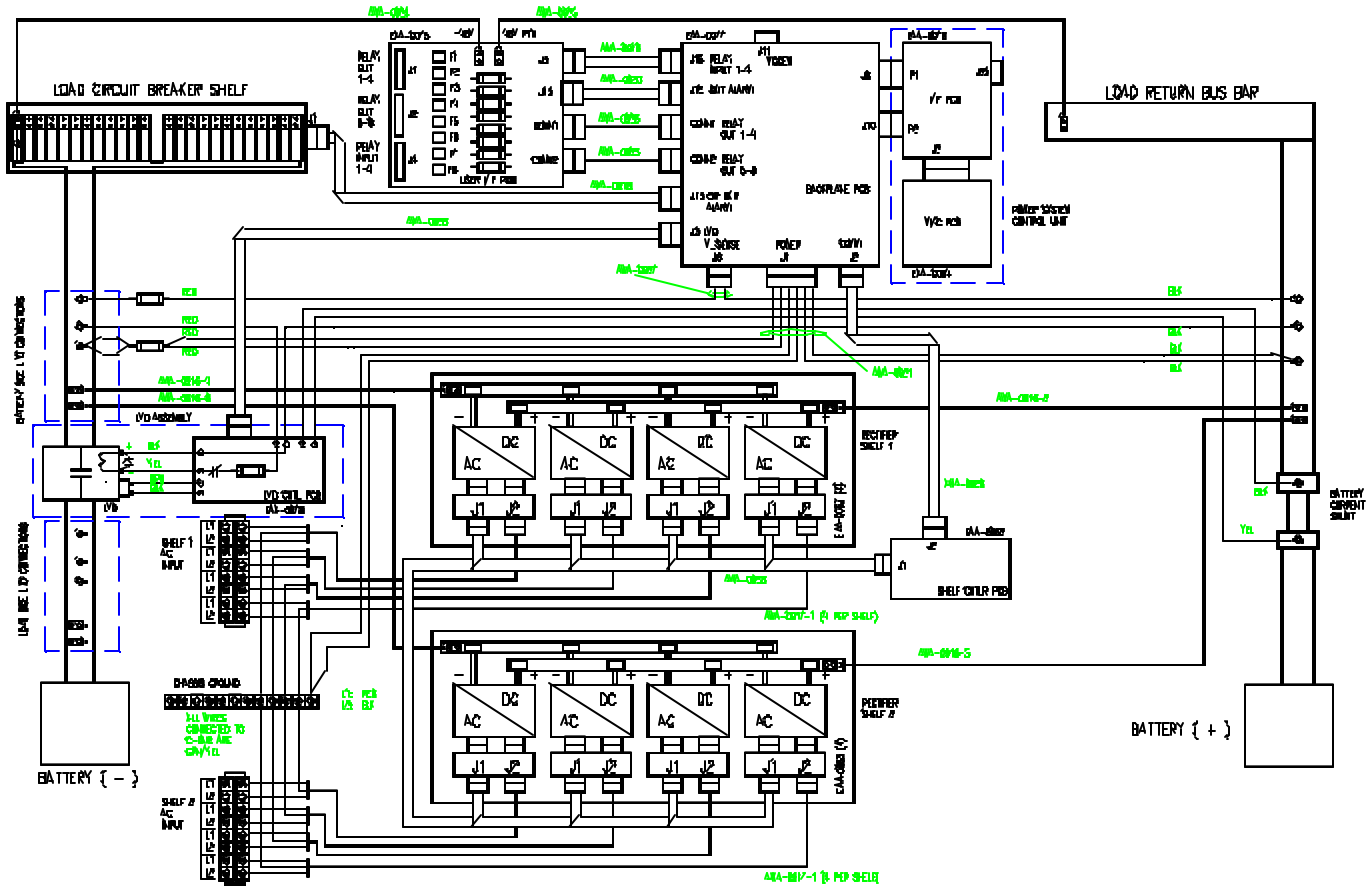


Figure 2.1-2 MX28B BLOCK DIAGRAM

2.2. How to Use This Manual

Each section of this manual can be read in any order and should provide a complete explanation of the subject described by the title. However, the sequence of the sections is designed to provide a typical step-by-step process for successful use of the equipment.

Safety First!		Safety symbol description and general precautions.
Introduction		Brief system preview and explanation of manual usage.
Installation		How to unpack, install and commission the equipment for initial use.
Operation		Specifics of controls settings and indicators used to operate the unit.
Remote Monitoring		Special remote monitoring and control features described with references to information on auxiliary equipment.
Specifications		Power plant and rectifier specifications.
APC Worldwide Customer Support		How to contact APC for customer support.
Warranty		Equipment warranty terms and conditions.

3 Installation

3.1. Unpacking Equipment

Remove equipment from packing material and inspect for shipping damage or missing items. It is important to report damage or material shortages to the shipping carrier while a representative is on site.

If concealed damage or material shortages are found at a later time, contact the shipper to make arrangements for inspection and claim filing. Refer to **Section 7** in the event it is necessary to return equipment to APC.

	**CAUTION**: Appropriate lifting techniques and safety equipment should be used to remove equipment from packing.

	**PLEASE RECYCLE**: The shipping materials can be recycled. Please save them for later use or dispose accordingly.

3.2. Mechanical Installation

Room / Location

NOTE: The APC Model MX28B DC power plant is to be installed in a room, vault, or similar enclosure that is accessible only to qualified persons in accordance with the NEC or the authority having jurisdiction.

Prior to installation, drawings, floor loading requirements, external alarm points, AC service entrance, and grounding schemes should all be checked and confirmed. If batteries are to be mounted in a room separate from the power plant, careful attention should be paid to battery cable voltage drop effects. Environmental operating temperatures and ventilation/cooling considerations should also be noted, not just for the power system but also for all other equipment that may reside in the power room area.

Mounting

Both front mounting on standard 23-inch rails and optional wall mounting are available.

Ventilation

The rectifier modules for this system have fans that provide front-to-rear airflow for internal cooling. The MX28B housing should mounted such that there is free airflow to the front, top, and bottom of the unit. [Refer to **Section 6.6** for environmental characteristics.]
Free airflow should be ensured so that the power system can provide full power at a given ambient temperature rating without de-rating.

3.3. AC Power Connections

	**WARNING**: Ensure that all of the external DC and AC circuit breakers are in the OFF position prior to connecting service to the power plant. Confirm that all voltages have been removed including any battery sources before proceeding**.**

The MX28B DC power plant requires the supply of 208/220/240/277 VAC single-phase, 50/60 Hz power through individual external 20-amp circuit breakers to the AC input terminal block connections for each rectifier module in the system. Two rectifier modules are required to accommodate the full AC input voltage range. The 1MRF28H54BV rectifier is designed for the standard 208/220/240 VAC input service, while the 1MRF28H54BV50 is used for the 277 VAC input. The AC wiring, from the AC input terminal block connections to the hot-pluggable AC input connector for each rectifier, is factory installed.

The AC input enclosure, located at the top right rear of the MX28B housing, is provided with two one-inch conduit entry holes and an access cover. Inside, a terminal strip(s) for AC input power connection and a separate “Earth Ground” bar for connection of the safety ground wire(s) are provided. The terminal block(s) is labeled as Position 1 through Position 4 (Position 1 through Position 8 for the 400-amp unit) with each position having inputs designated “L1” and “L2/N” for connection of the two AC wires. Positions 1-4 correspond to the top rectifier shelf positions from left to right. Positions 5-8 are applicable to the 400-amp unit only and correspond to the lower rectifier shelf positions from left to right.

The suggested wire size is #10 AWG rated at 90°C or higher; however, the ambient temperature and number of wires in a conduit must also be considered in accordance with NEC requirements. It is suggested that feeds for four rectifiers (8 wires) and one safety ground wire be run in a one-inch conduit; however, be sure to follow any local electrical wiring codes.

If the AC input power is provided from a three-phase distribution panel, the circuit breaker positions should be selected such that the load is balanced as much as possible.

	**WARNING**: The MX28B DC power plant is supplied from a nominal 220VAC, 60 Hz source. Keep the AC input enclosure in place when the system is operational or energized.

3.4. Battery Connections

	**WARNING**: Hazardous energy levels are present on bare conductors in the -48VDC distribution connection area of the plant. Accidental shorting of distribution conductors can cause arcing and high currents that can cause serious burns or other physical harm. It is recommended that: • Any jewelry, rings or watches be removed while working on this equipment. • Handles of all wrenches, screwdrivers, cutters and pliers be insulated. • Shafts of screwdrivers be wrapped in electrical tape or otherwise insulated

Planning the Battery installation

The battery cable(s) should be sized sufficiently large to limit the voltage drop from the MX28B DC power plant to the battery during charging per system design requirements. The cable(s) must also carry the full load current during battery operation. If assistance is required to determine the necessary cables for the application, contact your sales representative or APC.

An external fuse or circuit breaker (various options are available from APC) is required in the negative line (located at the battery end) to protect the cables from the battery to the MX28B DC power plant. The power plant can monitor auxiliary contacts from this breaker.

Connecting the Cables

	**WARNING**: Make certain that the battery polarity is correct when making connections to the Model MX28B DC power plant. Incorrect connection could cause severe equipment damage.

The battery cable connections are located at the top rear of the unit as shown in Figure 3.4-1. The battery positive (return bus) and battery negative (-48V bus) buses each provide two sets of threaded 3/8”-16 holes on one-inch centers for connecting two-hole battery cable lugs. Connect the battery cables as applicable using 3/8-16 bolts (not provided) and tighten them with a torque wrench to 200 in-lbs (23 N-m).

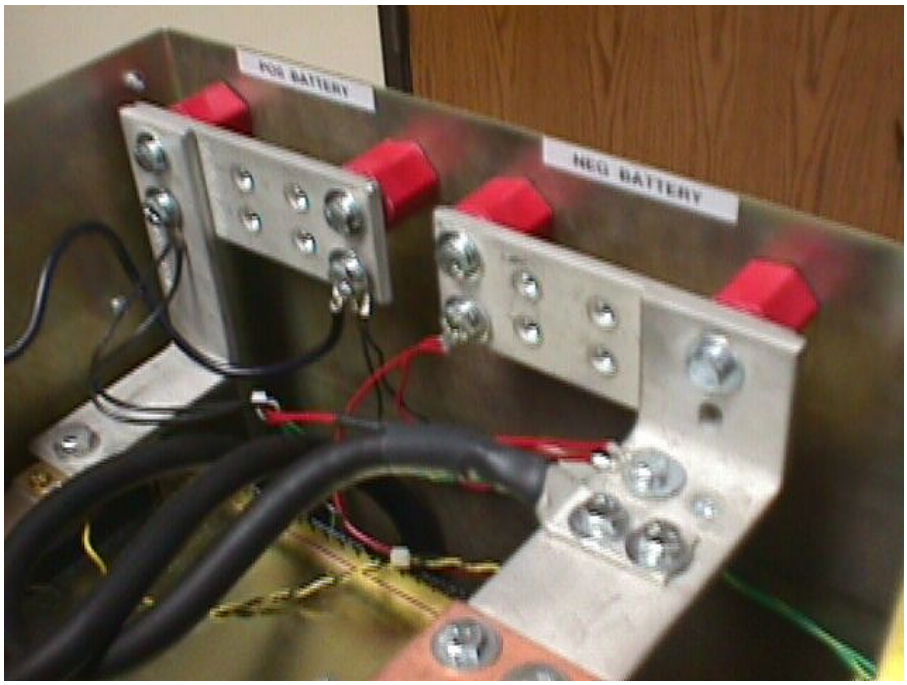


Figure 3.4-1 Battery Cable Connection Locations

Battery Temperature Probe Installation

The optional temperature probe is used to monitor the battery string temperature. To get the most representative temperature measurement, the probe should be placed in contact with a battery cell that is centrally located. The probe should be placed directly in contact with the cell (not the frame surrounding the cell). Generally, the cell cover can be used; be careful not to allow the probe body to touch the terminals. Plug the connector end of the temperature probe into J5 of the control unit backplane card. Route the cable as required positioning the probe on the selected battery cell. Remove the adhesive protection strip from the probe body and press the adhesive side of the probe on the battery cell cover.

3.5. DC SYSTEM GROUNDING

The Positive Battery connection (return bus) for the power plant must be connected to the Master Station Ground. The left end of the return bus provides a pair of threaded 3/8-16 holes on 1 inch (25.4 m) centers for connection of a two-hole lugged cable to the Master Station Ground. Details for this connection should be provided in the site electrical grounding plans.

3.6. DC Power Output Over-Current Protection

DC Circuit Breakers

A standard 24-position plug-in circuit breaker tier provides -48V distribution. Various circuit breaker sizes from 1 to 100 amps are available, with 60-100 amp breakers requiring two positions and a circuit breaker adapter kit. The breaker tier is connected at its center to the -48V DC bus, and each side has an ampacity of 300A. It is therefore necessary to balance the load on the MX28B-400 plant to avoid overloading the output bus. Also when planning the output installation, take into consideration the configuration of the plant and the number of rectifiers installed.
Any combination of up to 24 single (1-50 Amp) or up to 12 double (60-100 Amp) breakers may be installed. **Figure 3.6-1** shows the power plant's DC distribution section with the front cover removed.

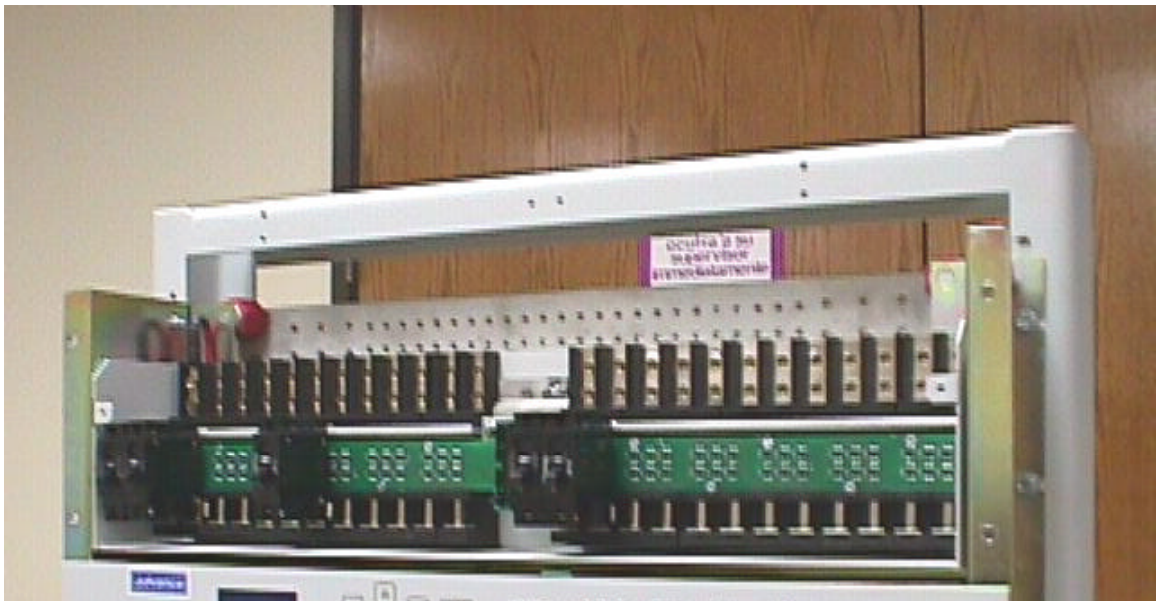


Figure 3.6-1 DC Distribution (Front Cover Removed)

Available plug-in circuit breakers are shown below. These are only breakers and do not include any hardware.

Plug-in Circuit Breakers

BREAKER RATING	PART NUMBER		BREAKER RATING	PART NUMBER
1 A	FFA-0014		40 A	FFA-0020
3 A	FFA-0015		50 A	FFA-0025
5 A	FFA-0016		60 A	530-9088
10 A	FFA-0017		70 A	530-9089
15 A	530-9093		80 A	530-9090
20 A	FFA-0018		100 A	530-9091
30 A	FFA-0019			

Plug-in circuit breakers rated at 60A or more require two mounting positions and require a circuit breaker adapter, which is included in the circuit breaker kit. Adaptors are available with studs for #10-32 nuts on 5/8" centers, #10-32 nuts on ¾" centers, or ¼-20 nuts on 1" centers. The circuit breaker kit includes all necessary mounting hardware. Available plug-in circuit breakers are shown below.

Plug-in Circuit Breaker Kits

BREAKER RATING	PART NUMBER	ADAPTOR SIZE
60 A	FFA-0021-1	#10 studs on 5/8" centers
60 A	FFA-0021-2	#10 studs on ¾" centers
60 A	FFA-0021-3	¼" studs on 1" centers
70 A	FFA-0022-1	#10 studs on 5/8" centers
70 A	FFA-0022-2	#10 studs on ¾" centers
70 A	FFA-0022-3	¼" studs on 1" centers
80 A	FFA-0023-1	#10 studs on 5/8" centers
80 A	FFA-0023-2	#10 studs on ¾" centers
80 A	FFA-0023-3	¼" studs on 1" centers
100 A	FFA-0024-1	#10 studs on 5/8" centers
100 A	FFA-0024-2	#10 studs on ¾" centers
100 A	FFA-0024-3	¼" studs on 1" centers

DC GMT Fuses

Eight GMT fused outputs are also available as an option. This option uses one of the 24 available circuit breaker positions. Connections to the GMT fuses are made at terminal block connectors labeled “F1” through “F8” that are located on the interface card mounted in the top left side of the unit. See Figure 2.1-1 for details. A list of GMT type fuses available from APC is provided below.

GMT Fuses

FUSE RATING	PART NUMBER
¼ A	FFA-0030
½ A	FFA-0031
3/4 A	FFA-0032
1 A	FFA-0033
1¼ A	FFA-0039
1½ A	FFA-0035
3 A	FFA-0036
5 A	FFA-0037
7½ A	FFA-0029
10 A	FFA-0038
Fuse cover	890-0052

3.7. Installation of Circuit Breakers and Fuses

Plug-in Circuit Breaker Installation

	**CAUTION** During circuit breaker installation, carefully align the breaker alarm terminals with the alarm terminal board to avoid breaker terminal damage.

1) Remove the circuit breaker cover panel and the plastic cover(s) from the desired location(s).
2) Install the circuit breaker(s) by snapping the top terminal onto the upper bus bar and rotating the unit down until the second terminal snaps onto the breaker termination post as shown in **Figure 3.7-1** The breaker alarm terminals are designed to make contact with the alarm terminal board as the breaker is snapped into place.
3) Reattach the circuit breaker cover panel.

NOTE: Circuit breaker alarm contacts close when the circuit breaker is tripped but not when it is turned OFF.

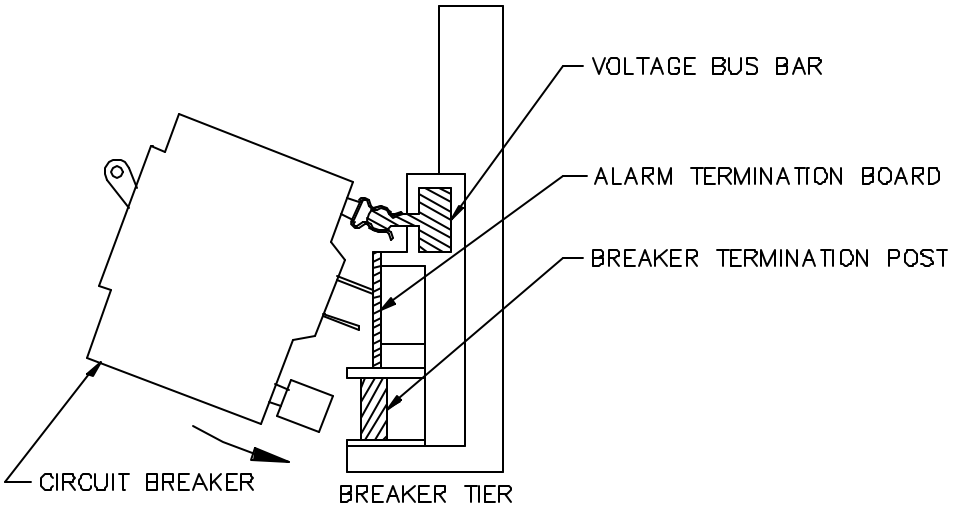


Figure 3.7-1. Installation of Circuit Breakers

GMT Fuse Installation

Fuse holders that accommodate GMT fuses are located on the interface card mounted in the top left side of the unit. Insert the fuse in the holder; observing the tripped indicator is correctly oriented. These fuse holders are only connected to -48VDC if the system has been purchased with the GMT fuse option. This option supplies -48VDC to lugs on the interface card through a 50 Amp circuit breaker located in circuit breaker Position 1. The interface card provides fuse holders for eight fuses, labeled "F1" through "F8", which can be used for small -48V DC loads. Use the chart shown in **Figure 3.7-2** to help determine what size fuses will carry the desired current. Refer to **Figure 3.8-3** for Interface board GMT fuse locations.

		AMBIENT TEMPERATURE		
		20° C	50° C	60° C
FUSE SIZE	10 Amp	7 Amp	6 Amp	5 Amp
	12 Amp	8 Amp	7 Amp	6 Amp
	15 Amp	10 Amp	9 Amp	8 Amp

Figure 3.7-2 GMT Fuse Temperature De-rating Chart

3.8. Load Connections

Cable Size Considerations

The DC load cable(s) should be sized sufficiently large to limit the voltage drop from the MX28B DC power plant to the loads per system design requirements. The cable(s) must also carry the full load current during battery operation. During battery operation the voltage will be lower and for constant power loads, therefore the current will typically be higher. If assistance is required to determine the necessary cables for the application, contact your sales representative or APC.

Circuit Breaker Connections (1 to 50 Amps)

Connections for 1 to 50 amp DC loads require standard two-hole lugs with holes for #10 screws (810-0032) on 5/8" centers and are located directly above the corresponding circuit breaker. The load returns connect to the return bus located just above and rearward of the breaker connection points as seen in Figure 3.8-1 The return bus provides 24 sets of threaded #10-32 holes on 5/8" centers and four sets of threaded ¼-20 holes on ¾" centers for connection of two-hole lugs on load return wires.

Load Connections should be made as shown in Figure 3.8-1

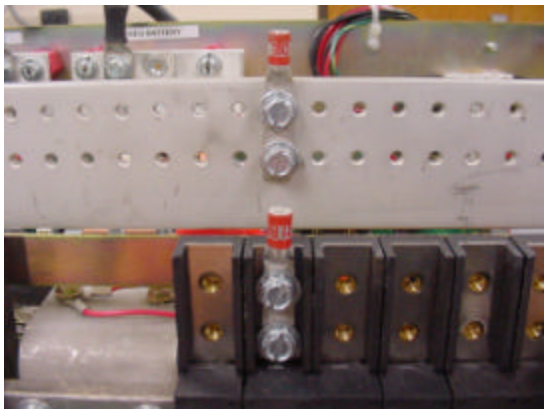


Figure 3.8-1 Standard lug for 1 to 50A breakers.

NOTE: Load return lugs are connected to the **front** of the return bus to prevent interfering with the top cover of the unit.

Circuit Breaker Connections (60-100 Amps)

Connections for 60 to 100 amp DC loads are twice as wide as the smaller breakers and therefore require two positions and a circuit breaker adapter kit. The adaptor connects the two output lug positions to one lug. Adaptors are available with studs for #10-32 nuts on 5/8" centers, #10-32 nuts on ¾" centers, or ¼-20 nuts on 1" centers. The adaptor is installed directly above the two positions the circuit breaker is mounted on using #10 screws provided in the kit. The lugs (not included with the kit) fasten on to the adaptor's studs using nuts and washers provided in the kit.

The load returns connect to the return bus located just above and rearward of the breaker connection points as seen in **Figure 2.1-1**. The return bus provides 24 sets of threaded #10-32 holes on 5/8" centers and four sets of threaded ¼-20 holes on ¾" centers for connection of two-hole lugs on load return wires.

Load Connections should be made as shown in **Figure 3.8-2.**

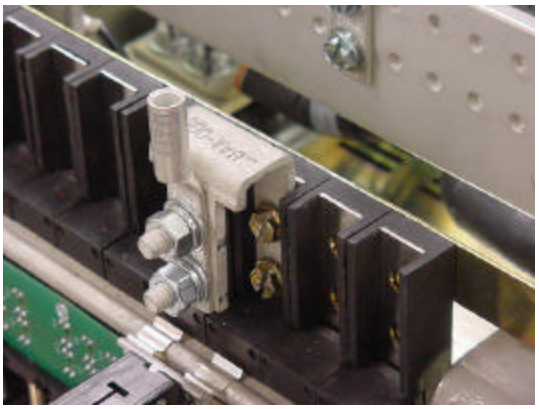


Figure 3.8-2 Adaptor and lugs for 60-100 Amp breakers

GMT Fuse Connections

GMT fuses are only connected to -48VDC if the system has been purchased with the GMT fuse option. This option supplies -48VDC to lugs on the interface card through #6 AWG power cables controlled by a 50 Amp circuit breaker located in circuit breaker Position 1. The 2-hole lugs on both ends of the power cables have #10 holes on 5/8" centers. Connections to the GMT fuses are made at terminal block connectors labeled "F1" through "F8" that are located on the interface card mounted in the top left side of the unit. The connector is sized to accept #12 – #28 AWG wire. Each connector has two positions, labeled "-48V" and "RTN", for connection of the -48V DC load and load return wires. Refer to **Figure 3.8-3** for Interface board connections.

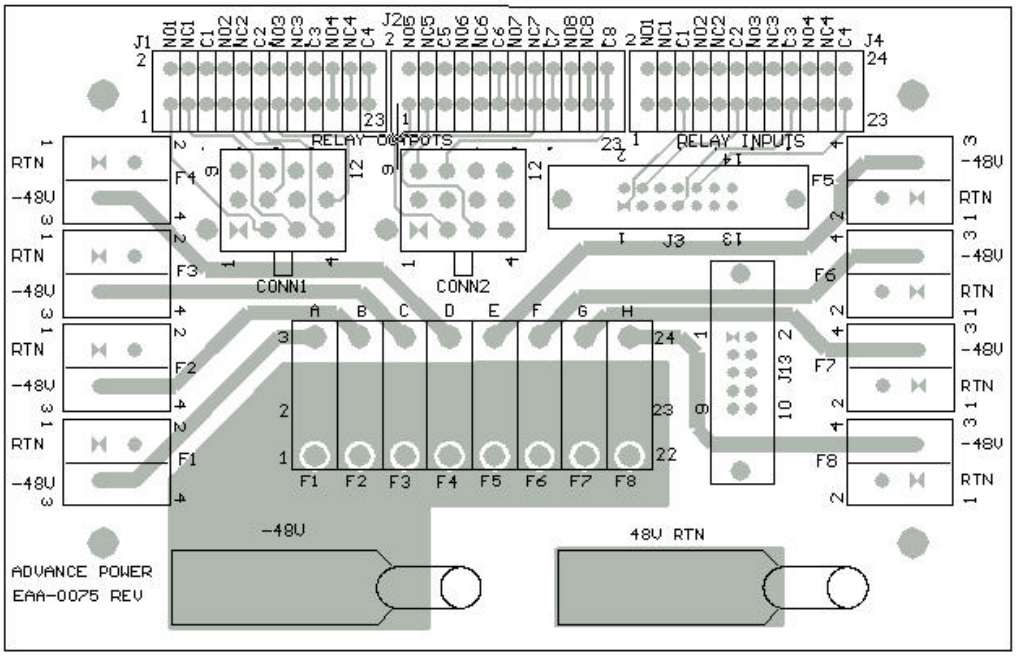


Figure 3.8-3 Interface Board

3.9. Monitoring and Relay Output Connections

Front Panel DB9 Connection

The front panel DB-9 connector is used to hook up a standard serial cable for the APC proprietary GUI that will be introduced at a later date. Do not hook up the special RS-232 cable (APC part number 940-0024C). This cable is only to be used with the DB-9 near the Web/SNMP card.

"Smart" Cable DB9 Connection

The DB9 connector on the top right hand side of the unit uses the special RS-232 cable (APC part number 940-0024C) to allow local access through a Terminal Emulation program like HyperTerminal™ or Procomm™ (**).

RJ45 Ethernet Connector

The optional management card has an RJ-45 connector to support a TCP/IP protocol over a 10BaseT Ethernet Local Area Network (LAN).

Relay Output Connections

There are eight alarms available that provide outputs via Form "C" relay contacts. The last two of these are preassigned as the Minor and Major relay outputs. The Major relay is energized (NO-C contacts closed) during normal (non-alarm) operating conditions; all the other relays energize when an alarm condition occurs. The other six outputs are initially designated as "Relay 1" through "Relay 6" (the user may assign more meaningful names if desired). The various system alarm conditions can be assigned to any of the eight alarm outputs. Connectors J1 and J2 are located on the interface card mounted in the top left side of the unit. Refer to the board layout in **Figure 3.8-3** for Output Relay connections. The relay contacts should only be used to switch resistive loads of 0.5 amperes or less at 60 volts or less. The following shows the alarm output connection designations.

Output Relay Connections

RELAY OUTPUT	TERMINAL DESIGNATION NO-NC-C	USER ALARM NOTES
	J1	
RELAY #1	NO1-NC1-C1	_____
RELAY #2	NO2-NC2-C2	_____
RELAY #3	NO3-NC3-C3	_____
RELAY #4	NO4-NC4-C4	_____
	J2	
RELAY #5	NO5-NC5-C5	_____
RELAY #6	NO6-NC6-C6	_____
MINOR	NO7-NC7-C7	_____
MAJOR	NO8-NC8-C8	_____

3.10. External Alarm Input Connections

Four external alarm inputs with assignable priority levels are available. These alarm inputs respond to external dry contact closures between normally open (NO) and common (C) or contact openings between normally closed (NC) and C.

External Alarm Input Definition

External Alarm Source (non-alarm state)	Connect To Input Alarm Terminals
OPEN	NO-C
CLOSED	NC-C

Connector J4 is located on the interface card mounted in the top left side of the unit. Refer to **Figure 3.8-3** for Interface board connections. Systems are shipped with jumper wires connecting each NC and corresponding C contact. A jumper wire should be removed only if the corresponding NC-C contacts are going to be used.

External Alarm Input Connections

EXTERNAL ALARM INPUT	J4 TERMINAL DESIGNATION (NO-NC-C)	USER ALARM NOTES
#1	NO1-NC1-C1	_____
#2	NO2-NC2-C2	_____
#3	NO3-NC3-C3	_____
#4	NO4-NC4-C4	_____

3.11. Rectifier Module Installation

	**WARNING**: Rectifier DC output circuits would be damaged if battery were installed incorrectly. Before rectifier installation, ensure proper battery polarity and that the battery is isolated from the rest of the system

The rectifier modules are shipped in separate containers. Follow the procedure below to install a rectifier module.

1) Remove the rectifier from its shipping container.

2) Remove any rectifier retaining screws from the shelf position where the rectifier is to be installed.

3) Slide the rectifier module into the shelf between the guides until it is fully seated.

4) Fasten the rectifier in place with the rectifier retaining screw (included in literature kit with product manual).

Since all adjustments are made from the system control unit, no rectifier adjustments are necessary.

NOTE: All "FLOAT" – "BOOST/EQUALISE" switches (one is located on the front of each rectifier in the system) must be set to "FLOAT" to allow the MX28B to control the output voltage properly.

	**CAUTION**: Rectifier fan inlet filters are available for dusty or hostile environments. Failure to periodically check and clean filters can lead to rectifier shutdown due to over temperature and produce power plant failure.

3.12. Initial Power-Up and Checkout

Before initiating power-up and checkout, ensure that the following conditions exist:

1) Make sure that the external circuit breaker protecting the cables from the battery to the power plant is turned **OFF** (the battery cables should be connected to the power plant, but the battery should **not** be connected).

2) Make sure that all load circuit breakers are turned **OFF** (including the one feeding the GMT fuses if the unit has the GMT fuse option).

3) Verify that all rectifiers have been installed.

4) Apply AC Power. Turn on the circuit breakers that supply ac power to the rectifiers in the MX28B DC power plant. The main screen should appear on the control unit display (see Figure 4.6-1). The display on the control unit is a 2-lines by 16-characters display. The cursor cycles below the characters of the active selection on the display. Information shown in the second line of Figure 4.6-1 that extends beyond 16 characters (to the right of the "S" in "ALARMS") can viewed on the control unit display by using the scrolling controls (refer to **Section 4.6** for operation of the control unit).

NOTE: When AC power is initially applied, there is a 60-second period during which no alarms are reported.

	**WARNING**: The DC power plant is supplied from a nominal 220VAC, 50/60 Hz source. Keep the AC input enclosure cover in place when the system is operational or energized

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3.13.System Parameters Verification/Adjustment

The MX28B system control unit is delivered with pre-programmed parameter default settings. A complete listing and description of all system configuration parameters as well as displayable system status and information is provided in **Section 4.6**. Read **Section 4.1** to gain an understanding of and how to use the operational features provided by the MX28B DC power plant. As a minimum, the following parameters should be verified and adjusted, if required, before connecting batteries or loads to the power plant:

1) **Battery Float Voltage** - default = -54.00V DC (Check the manufacturer's recommendation for the batteries being used in the system.)
2) **Battery Maximum Recharge Rate** - default = 12A. (Bellcore specifications recommend a maximum charging rate of capacity (in Ampere-hours) divided by 20 hours; check the manufacturer's recommendation.)
3) **System Voltage** - measurement ≅ -54.00V DC (This is a measurement by the system of the DC output bus voltage.)
4) **LVD Option** - default = "Enable" (If the MX28B does not have an LVD installed, this should be changed to "Disable".)
5) **Rectifier Information** - Check the rectifier information displays to verify that all rectifiers installed can be viewed on the control unit display and that no rectifier alarms are active.

Section 4.6 provides location information for these parameters and how to make changes if required.

3.14.Full System Power Up

To complete a full system power up, perform the following steps:

1) Turn **OFF** all the circuit breakers that supply ac power to the rectifiers in the MX28B DC power plant.

Turn on the external circuit breaker from the battery to the power plant.

Turn on all the circuit breakers that supply AC power to the rectifiers in the MX28B DC power plant.

Load circuit protection may now be enabled as required.

4 Operation

4.1. Technical Description

The MX28B-200/400 Power System is designed to supply safe –54 VDC primary power through the use of up to eight rectifier modules. In conjunction with an external battery string, it will supply backup power as well. The Power System Control Unit (PSCU) will monitor all MX28B functions and provides battery management including controlled battery recharge with temperature compensation and low voltage disconnect. Integrated DC output distribution supports loads ranging from ¼ Amp all the way to 100 Amp is available. Battery recharging, temperature compensation and low voltage disconnect are included. The controller can monitor up to 4 discrete external events with dry contact inputs.

4.2. Rectifier Management

AC Input Power

The basic component of the power system is the rectifier module, which rectifies utility AC into nominal 48 Volts DC. Each rectifier module requires 208/220/240V AC (MRF28H54BV), or 277V ac (MRF28H54BV50) single-phase, 50/60 Hz. A breaker installed in a remote panel should individually protect each rectifier circuit.

DC Output Power

The DC outputs of all the rectifiers in the system are connected to a common bus that is rated to carry the current of the entire system. The rectifier modules will equally share the entire load, independent of the PSCU. The rectifiers will continue to provide DC power if the PSCU is removed or fails.

Rectifier alarms reporting

The rectifier has numerous sensors inside the unit that monitor fan fail, high temperature, high/low voltage, etc. These rectifier sensors trigger outputs that are monitored by the PSCU. In addition rectifier current is measured inside each rectifier. The PSCU can trigger output relays in the event of a rectifier alarm. Refer to Section 4.6 for PSCU control functions.

4.3. System Management

System Output Capacity

The power plant has two basic configurations:
The MX28B-200 supplies a maximum of 200 amps or 150 amps with N+1 redundancy. The housing for this configuration provides space for one rectifier shelf that can hold up to four rectifiers, a control unit, and one tier of up to 24 distribution circuit breakers.
The MX28B-400 supplies a maximum of 400 amps or 350 amps with N+1 redundancy. The housing for this configuration provides space for two rectifier shelves that can hold up to four rectifiers each, a control unit, and one tier of up to 24 distribution circuit breakers. The differences between the 200 and 400 amp units are the exterior housing, 50-conductor ribbon cable and an additional rectifier shelf; all other parts are the same for both configurations.

System Voltage Control

The PSCU monitors and adjusts the system voltage. It uses a voltage trim input to the rectifier to precisely control the DC output voltage. In the event of PSCU removal or failure, the shelf rectifier controller card will control the voltage at a programmed default level. In the event of shelf rectifier controller card failure, the individual rectifiers will default to the analog voltage level preset with the front panel “float’ adjustment pots.

System Current

The PSCU monitors individual rectifier currents and displays total system current as a sum of rectifier currents. Load current can be found by adding battery current to system current. Battery Current is positive when the battery is discharging.

Sys Current + Batt current = Load Current

For example, if the battery is charging the Batt Current reading could be (–) 40 A, Sys Current reading could be 120 A. Load Current would be:

Sys Current + Batt current = Load Current
120A + (-) 40 A = 80 Amps.

If the battery is discharging the Batt Current reading would be 40 A, Sys Current would reading would be 40 A. Load voltage would be:

Sys Current + Batt current = Load Current
40A + 40 A = 80 Amps.

System Status and Alarm Reporting

The PSCU will monitor system voltage using a high accuracy digital voltmeter attached to the system bus. The PSCU will monitor system temperature using a temperature IC mounted in the PSCU. The PSCU will monitor system current by summing the current reported by individual rectifiers. The PSCU will report a number of system alarms including system high/low voltage and high/low temperature. Refer to Section 4.6 for PSCU control functions.

4.4. DC Distribution

Distribution is included for up to 24 plug-in circuit breakers. These circuit breakers can be 1 to 100 amps, with 60-100 amp breakers requiring two positions and a circuit breaker adapter kit. When a circuit breaker trips, a normally open switch closes and a CB alarm is reported by the PSCU. To disconnect a load attached to a circuit breaker, move the lever to the down "OFF" position.

NOTE: Circuit breaker alarm contacts close when the circuit breaker is tripped but not when it is turned OFF.

Eight GMT fused outputs are also available as an option. This option uses one of the 24 available circuit breaker positions. When a GMT fuse trips, an alarm spring is revealed that visually indicates the fuse is blown. The alarm spring also makes contact with a third contact on the fuse holder, which connects the –48 VDC bus voltage to the GMT fuse alarm input in the PSCU. Upon measuring voltage on this alarm circuit, the PSCU will report a GMT fuse alarm. To disconnect a load attached to a GMT fuse, pull the fuse out of the fuse socket.

NOTE: GMT fuse alarm contacts complete the alarm circuit when the fuse is tripped but not when the fuse is removed.

4.5. Battery Management

Battery Charging and Protection

Battery charging and protection are integrated into the MX28B DC power system to support the primary function of providing power to the load. Accurate measurement of battery parameters like voltage, current and temperature are used to maintain and protect the batteries attached to the power plant.

Charging the battery at the correct rate reduces battery heating, increases the charge returned to the battery and prevents excess hydrogen generation or, in the case of VRLA

batteries, possible thermal runaway. Battery Maximum Recharge Current is set to the appropriate rate, which is usually based on the size of the battery plant in Ampere-hours.

A typical recharge current setting is battery capacity (abbreviated as "C") divided by number of charging hours. As an example, a "C/10" rate will basically return the battery to full charge in 10 hours. A C/8 rate is probably the highest current, which should be considered for charging under normal circumstances.

Battery Temperature Compensation

The Battery Float Voltage is set to the value recommended by the battery manufacturer in order to maintain correct battery charge at 25ºC. As temperature rises, electrochemical activity in a battery increases. Similarly, as temperature falls, electrochemical activity in a battery decreases. As temperature rises charging voltage should be reduced to prevent overcharge and increased as temperature falls to prevent undercharge. The DC power system uses Battery Temperature compensation to change output voltage to compensate for temperature changes. This temperature compensation function is programmed into the PSCU using the compensation parameters settings. Default settings can be changed to values recommended by the particular battery manufacturer.

Battery/Load Low Voltage Disconnect

In order to prevent damage to the battery due to deep discharge, the DC power system has hardware and software support for a battery or load Low Voltage Disconnect (LVD). A battery LVD has the loads permanently attached to the rectifiers and the battery is disconnected from the system. A load LVD has the battery permanently attached to the rectifiers and the loads are disconnected from the system.

When the battery voltage reaches the threshold set by the *LVD 1 Trip Voltage* setting during discharge, the DC power system will activate the LVD contactor to disconnect the battery or load from the system. The LVD will remain open until AC power is restored to the system and the bus voltage reaches the level defined by the *LVD 1 Reset Voltage* variable.

NOTE: The LVD is normally energized and must be commanded to open. This assures that the LVD will remain closed even if the controller fails or is removed.

4.6. Controls and Indicators

Front Panel User Interface

The MX28B control unit provides a user interface designed with a hierarchical menu that can be viewed on the 32-character (2 X 16) display by "navigating" with the "⇦" (left), "⇨"

(right), "⇧" (up), and "⇩" (down) arrow keys located on the front panel. The selected item on the display is identified by the cursor cycling beneath its characters.

The "M" (modify) key and the arrow keys are used to set parameters and text to customize the system operation for a specific application. Items that can be modified have "m+" in the upper right corner of the display. If a security level higher than the one presently set is required to modify the parameter, "s+" is displayed instead of "m+". Status, alarms, and information screens have "+" in the upper right corner of the display (or "#" in the case of rectifier information screens) and cannot be modified. When AC power is initially applied, there is a 60-second period during which no alarms are reported.

Pressing the "M" key on the front panel will change the "m+" to "M+", indicating that the parameter can now be changed using the arrow keys. Some parameters can be changed to other predefined selections by pressing the up or down arrow keys to display an alternative selection. These parameters can be recognized after the "M" key is pressed by the cursor cycling beneath the characters of the selection. For other parameters, such as text and most numeric values, after the "M" key is pressed the cursor will be displayed under an individual character. The right or left arrow key is used to position the cursor below the character to be changed and the up or down arrow key is used to "spin" the digit or letter to the desired value. When the desired changes have been made to an individual parameter screen, the "M" key is pressed again; the "M+" changes back to "m+" and the new entry is stored in memory.

If the user plans to make any changes to system parameters, the first item that should be verified or entered is the appropriate password for the security level required for the parameters to be modified. Security level 2 (enter 2222 on the "PIN" screen) enables modification of all variable system parameters. Security level 1 (enter 1111 on the "PIN" screen) permits modification of some parameters. No security is required for viewing status items and parameter settings. The security level password is entered through the "PIN" screen. If no front panel keys are pressed for 60 minutes, the active security level password reverts to level 0 and "¦APC¦" begins to move about the display. Pressing any key returns the display to normal and the password must be re-entered if system parameters require changes.
Eleven LEDs are provided on the front panel of the control unit to indicate system status. Three LEDs grouped together vertically provide overall system status; they are "MAJOR", "MINOR", and "NORMAL", indicating the presence of a major alarm, a minor alarm, or normal operation. The other eight LEDs correspond to the active state of each of the alarm output relays and are labeled "ALM1"···"ALM6", "MIN", and "MAJ".

```
MX28B            +
   STATUS ALARMS SYSTEM MODULES BATT PIN OEM
```

Figure 4.6-1 Menu Top Line

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Parameter Locations, Descriptions, and Default Values

The location, description, and factory programmed default value for each of the MX28B system parameters is found in the table below. The table also shows all of the status and information screens with typical displays. The location of a parameter screen is shown in brackets, for example: **[SYSTEM/IN-RLY/RLY-MAP]**. To find the parameters that can be accessed in this category, starting from the main menu screen, do the following:

1) Use the right or left arrow keys to position the cycling cursor below "SYSTEM".

2) Press the down arrow key once.

3) Use the right arrow key to position the cycling cursor below "IN-RLY".

4) Press the down arrow key once; the cursor will be cycling below "RLY-MAP".

5) Press the down arrow key (repeatedly if necessary) until the desired parameter screen is displayed (there are eight parameter screens in this category).

After making any desired changes, return to the main menu press the up arrow key repeatedly.
If a parameter requires a level 1 or level 2 security access to permit changes to it, the security level will be found in braces, i.e. Security Level {2}, in the "PARAMETER" column of the table.

Parameter Locations, Descriptions, and Default Values

PARAMETER NAME/ [MENU LOCATION]	DESCRIPTION	DISPLAY SCREENS / DEFAULT SETTINGS
Address 1 Security Level {1} **[SYSTEM/SETUP]**	Power plant address or identification - first line.	`Address 1 m+` `APC DCNS, Inc.`
Address 2 Security Level {1} **[SYSTEM/SETUP]**	Power plant address or identification - second line.	`Address 2 m+` `11035 Switzer Av`
Address 3 Security Level {1} **[SYSTEM/SETUP]**	Power plant address or identification - third line.	`Address 3 m+` `Dallas, TX.`
Alarms Item 1 {Status Only} **[ALARMS]** • • • Alarms Item 16 **[ALARMS]**	Display of up to 16 active alarms (a typical alarm screen is shown). • • • Display of up to 16 active alarms (a typical alarm screen is shown).	`Alarm Item 1 +` `Batt LV Alm Onm` • • • `Alarm Item 16 +` `No Alarms`
Battery Current {Status Only} **[STATUS]**	Battery current measured by the system controller at the battery current shunt.	`Batt Current +` `-15.0 A`

PARAMETER NAME/ [MENU LOCATION]	DESCRIPTION	DISPLAY SCREENS / DEFAULT SETTINGS
Battery Discharge Alarm Security Level {1} **[BATT/SET-ALM]**	The output relay energized if the battery discharge current exceeds the programmed battery discharge threshold.	`Batt Disc Alm m+ Minor`
Battery Discharge Threshold Security Level {1} **[BATT/SET-ALM]**	An alarm is generated if the battery discharge current exceeds this value.	`Batt Disc Thr m+ 10 A`
Battery Float Voltage Security Level {1} **[BATT/PARAM]**	One of three parameters that control the DC output voltage. Set the Float Voltage at 25°C battery temperature per the battery manufacturers recommendations.	`Batt Float m+ -54.00 V`
Battery High Temperature Alarm Security Level {1} **[BATT/SET-ALM]**	The output relay energized if the battery temperature exceeds the Battery High Temperature threshold.	`Batt HT Alm m+ Minor`
Battery High Temperature Threshold Security Level {1} **[BATT/SET-ALM]**	Battery Temperature is temperature measured at the battery probe. An alarm is generated if the battery temperature exceeds this value.	`Batt HT Thr m+ 70.0 C`
Battery High Voltage Alarm Security Level {1} **[BATT/SET-ALM]**	The output relay energized if the DC output voltage rises above the battery high voltage threshold.	`Batt HV Alm m+ Minor`
Battery High Voltage Threshold Security Level {1} **[BATT/SET-ALM]**	An alarm will be reported if temperature is lower than the temperature entered. An alarm is generated if the DC output voltage rises above this value.	`Batt HV Thr m+ -58.00 V`
Battery Low Temperature Alarm Security Level {1} **[BATT/SET-ALM]**	The output relay energized if the Battery Temperature drops below the battery Low Temperature threshold.	`Batt LT Alm m+ Minor`
Battery Low Temperature Threshold Security Level {1} **[BATT/SET-ALM]**	Battery Temperature is temperature measured at the battery probe. An alarm is generated if the battery temperature drops below this value.	`Batt LT Thr m+ 0.0 C`
Battery Low Voltage Alarm Security Level {1} **[BATT/SET-ALM]**	The output relay energized if the DC output voltage drops below the battery low voltage threshold.	`Batt LV Alm m+ Minor`
Battery Low Voltage Threshold Security Level {1} **[BATT/SET-ALM]**	An alarm is generated if the DC output voltage drops below this value.	`Batt LV Thr m+ -44.00 V`
Battery Maximum Recharge Current Security Level {1} **[BATT/PARAM]**	One of three parameters that control the DC output voltage. If Battery Current surpasses the Maximum Battery Recharge Current, the DC output voltage will be reduced (the system limits the charging current to this programmable value).	`Batt Max Rechm+ 12 A`
Battery Temperature {Status Only} **[STATUS]**	Battery temperature measured by the system controller at the optional battery temperature sensor probe.	`Batt Temp + 25.2 C`

PARAMETER NAME/ [MENU LOCATION]	DESCRIPTION	DISPLAY SCREENS / DEFAULT SETTINGS
Circuit Breaker 1 Alias Security Level {1} **[MODULES/CIRBKR/ALIAS]** • • • Circuit Breaker 24 Alias Security Level {1} **[MODULES/CIRBKR/ALIAS]**	An alternate name (alias) that can be assigned to a circuit breaker if desired. • • • An alternate name (alias) that can be assigned to a circuit breaker if desired.	Cir Bkr 1 m+ -48V • • • Cir Bkr 24 m+ -48V
Circuit Breaker 1 Tripped Security Level {1} **[MODULES/CIRBKR/SET-ALM]** • • • Circuit Breaker 24 Tripped Security Level {1} **[MODULES/CIRBKR/SET-ALM]**	An alarm that indicates Circuit Breaker 1 is tripped. • • • An alarm that indicates Circuit Breaker 24 is tripped.	Cir Bkr 1 Alm m+ Major • • • Cir Bkr 24 Almm+ Major
Compensation High Knee Security Level {1} **[BATT/COMP]**	The temperature compensation high knee is the point above which there is no additional battery voltage compensation for further increases in temperature.	Comp Hknee m+ 40.0 C
Compensation Low Knee Security Level {1} **[BATT/COMP]**	The temperature compensation low knee is the point below which there is no additional battery voltage compensation for further decreases in temperature.	Comp Lknee m+ 0.0 C
Compensation Method Security Level {1} **[BATT/COMP]**	One of three parameters that control the DC output voltage. Activate “ON” or de-activate “OFF” battery temperature compensation.	Comp Method m+ OFF
Compensation Temperature Coefficient Security Level {1} **[BATT/COMP]**	Temperature compensation coefficient between low knee and high knee in mV/cell/°C. (Compensation equals zero at 25°C.)	Comp TC m+ - 3.00mV
Control Unit Revision {Status Only} **[SYSTEM/SETUP]**	Hardware revision level of the control unit. This parameter cannot be changed.	Cntrl Rev + 000002
Date Security Level {1} **[SYSTEM/DATE]**	Internal system calendar date. Used as a date stamp in the event log.	Date m+ DEC 16 1999
Display Type {Status Only} **[SYSTEM/SETUP]**	Type number for the control unit display. This parameter cannot be changed.	Display Type + 000255
Fahrenheit Scale Security Level {1} [**SYSTEM/SETUP]**	Enables selection of Fahrenheit or Celsius temperature scale (Fahrenheit “OFF” displays readings in °C).	Fahrenheit m+ OFF

PARAMETER NAME/ [MENU LOCATION]	DESCRIPTION	DISPLAY SCREENS / DEFAULT SETTINGS
Firmware Version {Status Only} **[SYSTEM/SETUP]**	Version number of the control unit firmware. **NOTE: Actual firmware version number displayed is the current version as of the date of manufacture.** This parameter cannot be changed.	FW Version + 000189
GMT 1 Alias Security Level {1} **[MODULES/GMT/ALIAS]** • • • GMT 8 Alias Security Level {1} **[MODULES/GMT/ALIAS]**	An alternate name (alias) that can be assigned to a GMT Fuse 1 if desired. • • • An alternate name (alias) that can be assigned to a GMT Fuse 8 if desired.	GMT 1 m+ -48V • • • GMT 8 m+ -48V
GMT 1 Blown Security Level {1} **[MODULES/GMT/SET-ALM]** • • • GMT 8 Blown Security Level {1} **[MODULES/GMT/SET-ALM]**	The Output Relay that is energized when GMT Fuse 1 is blown. • • • The Output Relay that is energized when GMT Fuse 8 is blown.	GMT 1 Alm m+ Major • • • GMT 8 Alm m+ Major
Hardware Battery Current Alarm Security Level {2} **[SYSTEM/SET-ALM]**	The output relay energized if there is a hardware failure in the battery current monitoring function.	Hw Batt C Almm+ Minor
Hardware Battery Temperature Alarm Security Level {2} **[SYSTEM/SET-ALM]**	The output relay energized if there is a hardware failure in the battery temperature monitoring function.	Hw Batt T Almm+ Minor
Hardware LVD Alarm Security Level {2} **[SYSTEM/SET-ALM]**	The output relay energized if there is a conflict between the commanded and sensed positions of the LVD contactor. Generally the contactor is open when it should be closed.	Hw LVD Alm m+ Minor
Hardware System Temperature Alarm Security Level {2} **[SYSTEM/SET-ALM]**	The output relay energized if there is a hardware failure in the system temperature monitoring function.	Hw Sys T Alm m+ Minor
Hardware System Voltage Alarm Security Level {2} **[SYSTEM/SET-ALM]**	The output relay energized if there is a hardware failure in the system voltage monitoring function.	Hw Sys V Alm m+ Minor

PARAMETER NAME/ [MENU LOCATION]	DESCRIPTION	DISPLAY SCREENS / DEFAULT SETTINGS
Input Relay 1 Security Level {1} **[SYSTEM/IN-RLY/RLY-MAP]** • • • Input Relay 4 Security Level {1} **[SYSTEM/IN-RLY/RLY-MAP]**	The Output Relay that is energized when an external contact closure or opening at the Input Relay 1 connection changes state. • • • The Output Relay that is energized when an external contact closure or opening at the Input Relay 4 connection changes state.	In-Rly 1 Alm m+ Ignore • • • In-Rly 4 Alm m+ Ignore
Input Relay 1 Alias Security Level {1} **[SYSTEM/IN-RLY/ALIAS]** • • • Input Relay 4 Alias Security Level {1} **[SYSTEM/IN-RLY/ALIAS]**	An alternate name (alias) can be assigned to Input Relay 1 if desired. • • • An alternate name (alias) can be assigned to Input Relay 1 if desired	In-Rly 1 m+ Input Relay 1 • • • In-Rly 4 m+ Input Relay 4
Lamp Test Security Level {1} **[SYSTEM/DIAG]**	Setting Lamp Test to “ON” will turn on the “MAJOR”, “MINOR”, “NORMAL”, “MAJ”, and “MIN” LEDs on the control unit front panel.	Lamp Test m+ OFF
LVD 1 or 2 Option Security Level {1} **[MODULES/LVD/SET-ALM]**	Must be set to “Enable” if the unit has an LVD. If the unit has an LVD, but it is disabled, the controller will not disconnect the LVD.	LVD Option m+ Enable
LVD 1 or 2 Reset Security Level {1} **[MODULES/LVD/PARAM]**	LVD Reset (reconnect) threshold voltage.	LVD Reset m+ -48.00 V
LVD 1 or 2 Trip Security Level {1} **[MODULES/LVD/PARAM]**	LVD Trip (disconnect) threshold voltage.	LVD Trip m+ -42.00 V
LVD Alarm Security Level {1} **[MODULES/LVD/SET-ALM]**	The output relay that is energized when the controller opens the LVD. If unit has a battery LVD, no power will be available to turn on any Output Relays.	LVD Open Alm m+ Minor
Model Programming Security Level {2} **[SYSTEM/SETUP]**	Model type number for the MX28B DC power plant **NOTE: Changing the model number causes the system to reinitialize.**	Model m+ MX28B-200/400
OEM R Gain Security Level {2} **[OEM]**	Voltage gain adjustment for factory calibration of system voltage readings/settings.	OEM R Gain m+ 1.000 V
OEM R Offset Security Level {2} **[OEM]**	Voltage offset adjustment for factory calibration of system voltage readings/settings.	OEM R Offset m+ 0.000 V
OEM S Gain Security Level {2} **[OEM]**	Current gain adjustment for factory calibration of battery current readings/settings.	OEM S Gain m+ 1.000 A

PARAMETER NAME/ [MENU LOCATION]	DESCRIPTION	DISPLAY SCREENS / DEFAULT SETTINGS
OEM S Offset Security Level {2} **[OEM]**	Current offset adjustment for factory calibration of battery current readings/settings.	OEM S Offset m+ 0.0 A
Output Relay 1 Alarm Security Level {1} **[SYSTEM/OUT-RLY/RLY-MAP]** • • • Output Relay 6 Alarm Security Level {1} **[SYSTEM/OUT-RLY/RLY-MAP]**	Output Relay 1 Alarm can be "mapped" to activate other output relays ("Ignore" activates no additional relays). • • • Output Relay 6 Alarm can be "mapped" to activate other output relays ("Ignore" activates no additional relays).	Out-Rly 1 Alm m+ Ignore • • • Out-Rly 6 Alm m+ Ignore
Output Relay 1 Alias Security Level {1} **[SYSTEM/OUT-RLY/ALIAS]** • • • Output Relay 6 Alias {1} **[SYSTEM/OUT-RLY/ALIAS]**	An alternate name (alias) can be assigned to Output Relay 1 if desired. • • • An alternate name (alias) can be assigned to Output Relay 6 if desired.	Out-Rly 1 m+ Relay 1 • • • Out-Rly 6 m+ Relay 6
Output Relay 1 Delay Security Level {1} **[SYSTEM/OUT-RLY/RLY-MAP]** • • • Output Relay 6 Delay Security Level {1} **[SYSTEM/OUT-RLY/RLY-MAP]**	Delay between sensing of the alarm condition and activation of Output Relay 1. An alarm condition must exist for longer than the delay to be activated. • • Delay between sensing of the alarm condition and activation of Output Relay 6. An alarm condition must exist for longer than the delay to be activated.	Out-Rly 1 Dly m+ 0 sec • • • Out-Rly 6 Dly m+ 0 sec
Output Relay Major Alias Security Level {1} **[SYSTEM/OUT-RLY/ALIAS]**	An alternate name (alias) can be assigned to the major Relay if desired.	Relay Major m+ Major
Output Relay Minor Alias Security Level {1} **[SYSTEM/OUT-RLY/ALIAS]**	An alternate name (alias) can be assigned to the Minor Relay if desired.	Relay Minor m+ Minor
PIN 1 change Security Level {2} **[SYSTEM/SETUP]**	Permanently change password (PIN) that permits security Level 1 parameter changes - limited access.	PIN m+ 1111
PIN 2 Change Security Level {2} **[SYSTEM/SETUP]**	Permanently change password (PIN) that permits security Level 2 parameter changes - unlimited access.	PIN 2 m+ 2222

PARAMETER NAME/ [MENU LOCATION]	DESCRIPTION	DISPLAY SCREENS / DEFAULT SETTINGS
PIN Entry Security Level {0} **[PIN]**	Screen for entry of the active password (PIN). Before any changes can be made, the correct pin for the desires security level must be entered. Level 0 – full read access. Level 1 –full read and limited write access. Level 2 – full read and write access.	PIN m+ 0000
Rectifier Communications Fail Timeout Security Level {1} **[MODULES/RECT/PARAM]**	The maximum rectifier communications response time allowed before a communications failure is declared.	RectFailComm m+ 1 min
Rectifier Configuration Alarm Security Level {1} **[SYSTEM/SET-ALM]**	The output relay energized if the rectifier configuration differs from its stored configuration. This occurs if a rectifier is added after configuration.	Rect Cfg Alm m+ Minor
Rectifier Current Limit Alarm Security Level {1} **[MODULES/RECT/SET-ALM]**	The output relay that is energized or special rectifier alarm group n of N that occurs when a rectifier has been forced into the current limited mode.	Rect CL Alm m+ n of N
Rectifier Current Limit Alarm Status {Status Only} **[MODULES/RECT/INFO]**	The status will be "ON" if the rectifier has been forced into its current limited mode. **NOTE: This information can be viewed for each rectifier installed by using the horizontal arrow keys.**	Rect 1 CL # OFF
Rectifier Current Output Status {Status Only} **[MODULES/RECT/INFO]**	A display of the DC output current for the individual rectifier. **NOTE: This information can be viewed for each rectifier installed by using the horizontal arrow keys.**	Rect 1 Curr # 24.9 A
Rectifier Description {Status Only} **[MODULES/RECT/INFO]**	Displays the model number of the installed rectifier. **NOTE: This information can be viewed for each rectifier installed by using the horizontal arrow keys.**	Rect 1 Desc # MRF28H54
Rectifier Fail 1-of-N Alarm Security Level {1} **[SYSTEM/SET-ALM]**	The output relay energized if Rectifier Fail 1-of-N alarm occurs. This is a special rectifier alarm group that signifies that one rectifier has at least one alarm condition.	Rect 1ofN Almm+ Minor
Rectifier Fail 2-of-N Alarm Security Level {1} **[SYSTEM/SET-ALM]**	The output relay energized if Rectifier Fail 2-of-N alarm occurs This is a special rectifier alarm group that signifies that more than one rectifier has at least one alarm condition.	Rect 2ofN Almm+ Major
Rectifier Fail Safe Voltage Security Level {1} **[MODULES/RECT/PARAM]**	Rectifier default output voltage if communication with the control unit fails.	Rect Fail Safem+ -54.00 V
Rectifier Fan Fail Alarm Security Level {1} **[MODULES/RECT/SET-ALM]**	The output relay that is energized or special rectifier alarm group n of N that occurs when a rectifier fan has failed.	Rect FF Alm m+ n of N

PARAMETER NAME/ [MENU LOCATION]	DESCRIPTION	DISPLAY SCREENS / DEFAULT SETTINGS
Rectifier Fan Fail Alarm Status {Status Only} **[MODULES/RECT/INFO]**	The status will be "ON" if the rectifier fan has failed. **NOTE: This information can be viewed for each rectifier installed by using the horizontal arrow keys.**	Rect 1 FF # OFF
Rectifier Fault Alarm (RFA) Status {Status Only} **[MODULES/RECT/INFO]**	The status will be on if the rectifier output has failed. **NOTE: This information can be viewed for each rectifier installed by using the horizontal arrow keys.**	Rect 1 RFA # OFF
Rectifier RFA Alarm Security Level {1} **[MODULES/RECT/SET-ALM]**	The output relay that is energized or special rectifier alarm group n of N that occurs when a rectifier output has failed.	Rect RFA Alm m+ n of N
Rectifier Standby Alarm Security Level {1} **[MODULES/RECT/SET-ALM]**	The output relay that is energized or special rectifier alarm group n of N that occurs when the control unit is holding a rectifier in the standby mode.	Rect Stdby Almm+ n of N
Rectifier Standby Alarm Status {Status Only} **[MODULES/RECT/INFO]**	The status will be "ON" if the control unit is holding the rectifier in the standby mode. **NOTE: This information can be viewed for each rectifier installed by using the horizontal arrow keys.**	Rect 1 Stdby # OFF
Store Configuration Security Level {1} **[SYSTEM/DIAG]**	Setting this parameter to "Enable" will cause the current rectifier configuration to be stored (the display toggles back to "Disable" after entry).	Store Cfg m+ Disable
System Current {Status Only} **[STATUS]**	The total system output current (calculated as the sum of the individual rectifier output currents).	Sys Current + 145.8 A
System High Temperature Alarm Security Level {1} **[SYSTEM/SET-ALM]**	The output relay energized if the System Temperature exceeds the system high temperature threshold.	Sys HT Alm m+ Minor
System High Temperature Threshold Security Level {1} **[SYSTEM/SET-ALM]**	System Temperature is ambient temperature measured inside the controller. An alarm will be reported if temperature is higher than the temperature entered.	Sys HT Thr m+ 70.0 C
System High Voltage alarm Security Level {1} **[SYSTEM/SET-ALM]**	The output relay energized if the System Voltage is above the System High Voltage threshold.	Sys HV Alm m+ Minor
System High Voltage Threshold Security Level {1} **[SYSTEM/SET-ALM]**	System Voltage is bus voltage measured by the controller. An alarm will be reported if voltage is higher than the voltage entered.	Sys HV Thr m+ -58.00 V
System Low Temperature Alarm Security Level {1} **[SYSTEM/SET-ALM]**	The output relay energized if the System Temperature is below the System Low Temperature threshold.	Sys LT Alm m+ Minor

PARAMETER NAME/ [MENU LOCATION]	DESCRIPTION	DISPLAY SCREENS / DEFAULT SETTINGS
System Low Temperature Threshold Security Level {1} **[SYSTEM/SET-ALM]**	System Temperature is ambient temperature measured inside the controller. An alarm will be reported if temperature is lower than the temperature entered.	Sys LT Thr m+ 0.0 C
System Low Voltage Alarm Security Level {1} **[SYSTEM/SET-ALM]**	The output relay energized if the System Voltage is below the System Low Voltage threshold.	Sys LV Alm m+ Minor
System Low Voltage Threshold Security Level {1} **[SYSTEM/SET-ALM]**	System Voltage is bus voltage measured by the controller. An alarm will be reported if voltage is lower than the voltage entered.	Sys LV Thr m+ -50.00 V
System Temperature {Status Only} **[STATUS]**	System temperature measured within the control unit.	Sys Temp + 26.7 C
System Voltage {Status Only} **[STATUS]**	System output voltage measured between the MX28B DC power plant -48V and return buses.	Sys Voltage + -54.00 V
Test Major Relay Security Level {1} **[SYSTEM/DIAG]**	Setting this parameter to "ON" de-energizes the Major Relay and turns on the "MAJ" LED on the control unit front panel. In normal operation Major Relay is energized so that when a loss of –48 VDC power occurs, the relay will change state.	Test Maj Rly m+ OFF
Test Minor Relay Security Level {1} **[SYSTEM/DIAG]**	Setting this parameter to "ON" energizes the Minor Relay and turns on the "MIN" LED on the control unit front panel.	Test Min Rly m+ OFF
Test Relay 1 Security Level {1} **[SYSTEM/DIAG]** • • • Test Relay 6 Security Level {1} **[SYSTEM/DIAG]**	Setting this parameter to "ON" energizes Relay 1 and turns on the "ALM1" LED on the control unit front panel. • • • Setting this parameter to "ON" energizes Relay 6 and turns on the "ALM6" LED on the control unit front panel.	Test Relay 1 m+ OFF • • • Test Relay 6 m+ OFF
Test Relay Enable Security Level {1} **[SYSTEM/DIAG]**	This parameter must be set to "Enable" to permit the eight output relays to be manually tested; otherwise, the state of the relays will be per system conditions.	Test Relay En m+ Disable
Time Security Level {1} **[SYSTEM/DATE]**	Internal system clock time (24-hour format). Used as a date stamp in the event log.	Time m+ 9:00:25

Control Unit Menu Structure

The complete menu structure shown in the order in which it is accessed from the control unit display is presented in outline form below. Each indentation to the right represents a menu level below the indicated title.

Top Level	Second Level	Third Level	Fourth Level
MX28B200/400 + STATUS ALARMS	Sys Voltage		
•	Sys Current		
•	Sys Temp		
•	Batt Current		
•	Batt Temp		
MX28B200/400 + US ALARMS SYSTEM	Alarm Item 1		
•	Alarm Item 2		
•	Alarm Item 3		
•	•		
•	•		
•	•		
•	Alarm Item 14		
•	Alarm Item 15		
•	Alarm Item 16		
MX28B200/400 + MS SYSTEM MODULE	SYS + SET-ALM SETUP DA	Sys HV Thr	
•	•	Sys HV Alm	
•	•	Sys LV Thr	
•	•	Sys LV Alm	
•	•	Rect Cfg Alm	
•	•	Rect 1ofN Alm	
•	•	Rect 2ofN Alm	
•	•	Sys HT Thr	
•	•	Sys HT Alm	
•	•	Sys LT Thr	
•	•	Sys LT Alm	
•	•	Hw Sys V Alm	
•	•	Hw Batt C Alm	

Top Level	Second Level	Third Level	Fourth Level
•	•	Hw Batt T Alm	
•	•	Hw Sys T Alm	
•	•	Hw LVD Alm	
•	SYS: + LM SETUP DATE	PIN 1	
•	•	PIN 2	
•	•	Address 1	
•	•	Address 2	
•	•	Address 3	
•	•	Model	
•	•	Fahrenheit	
•	•	Cntrl Rev	
•	•	FW Version	
•	•	Display Type	
•	SYS: + LY DATE OUT-RLY	Date	
•	•	Time	
•	SYS: + TE OUT-RLY IN-R	SYS:OUT: + RLY-MAP ALIAS	Out-Rly 1 Alm
•	•	•	Out-Rly 2 Alm
•	•	•	Out-Rly 3 Alm
•	•	•	Out-Rly 4 Alm
•	•	•	Out-Rly 5 Alm
•	•	•	Out-Rly 6 Alm
•	•	•	Out-Rly 1 Dly
•	•	•	Out-Rly 2 Dly
•	•	•	Out-Rly 3 Dly
•	•	•	Out-Rly 4 Dly
•	•	•	Out-Rly 5 Dly
•	•	•	Out-Rly 6 Dly
•	•	SYS:OUT: + AP ALIAS	Out-Rly 1
•	•	•	Out-Rly 2
•	•	•	Out-Rly 3

Top Level	Second Level	Third Level	Fourth Level
•	•	•	Out-Rly 4
•	•	•	Out-Rly 5
•	•	•	Out-Rly 6
•	•	•	Relay Minor
•	•	•	Relay Major
•	SYS: + LY IN-RLY DIAG	SYS:IN-: + RLY-MAP ALIAS	In-Rly 1 Alm
•	•	•	In-Rly 2 Alm
•	•	•	In-Rly 3 Alm
•	•	•	In-Rly 4 Alm
•	•	SYS:IN-: + AP ALIAS	In-Rly 1
•	•	•	In-Rly 2
•	•	•	In-Rly 3
•	•	•	In-Rly 4
•	SYS: + LY DIAG	Store Cfg	
•	•	Lamp Test	
•	•	Test Relay En	
•	•	Test Relay 1	
•	•	Test Relay 2	
•	•	Test Relay 3	
•	•	Test Relay 4	
•	•	Test Relay 5	
•	•	Test Relay 6	
•	•	Test Min Rly	
•	•	Test Maj Rly	
MX28B200/400 + EM MODULES BATT	MOD: + RECT CIR-BKR	MOD:REC: + SET-ALM PARAM I	Rect CL Alm
•	•	•	Rect Stdby Alm
•	•	•	Rect FF Alm
•	•	•	Rect RFA Alm
•	•	MOD:REC: + LM PARAM INFO	Rect Fail Safe
•	•	•	Rect Fail Comm

Top Level	Second Level	Third Level	Fourth Level
•	•	MOD:REC: + AM INFO	Rect # Desc
•	•	•	Rect # Curr
•	•	•	Rect # CL
•	•	•	Rect # Stdby
•	•	•	Rect # FF
•	•	•	Rect # RFA
•	MOD: + CT CIR-BKR GMT	MOD:CIR: + SET-ALM ALIAS	Cir Bkr 1 Alm
•	•	•	Cir Bkr 2 Alm
•	•	•	Cir Bkr 3 Alm
•	•	•	•
•	•	•	•
•	•	•	•
•	•	•	Cir Bkr 22 Alm
•	•	•	Cir Bkr 23 Alm
•	•	•	Cir Bkr 24 Alm
•	•	MOD:CIR: + LM ALIAS	Cir Bkr 1
•	•	•	Cir Bkr 2
•	•	•	Cir Bkr 3
•	•	•	•
•	•	•	•
•	•	•	•
•	•	•	Cir Bkr 22
•	•	•	Cir Bkr 23
•	•	•	Cir Bkr 24
•	MOD: + KR GMT LVD	MOD:GMT: + SET-ALM ALIAS	GMT 1 Alm
•	•	•	GMT 2 Alm
•	•	•	GMT 3 Alm
•	•	•	GMT 4 Alm
•	•	•	GMT 5 Alm
•	•	•	GMT 6 Alm

Top Level	Second Level	Third Level	Fourth Level
•	•	•	GMT 7 Alm
•	•	•	GMT 8 Alm
•	•	MOD:GMT: + LM ALIAS	GMT 1
•	•	•	GMT 2
•	•	•	GMT 3
•	•	•	GMT 4
•	•	•	GMT 5
•	•	•	GMT 6
•	•	•	GMT 7
•	•	•	GMT 8
•	MOD: + MT LVD	MOD:LVD: + SET-ALM PARAM	LVD 1 Option
•	•	•	LVD 1 Open Alm
•	•	•	LVD 2 Option
•	•	•	LVD 2 Open Alm
•	•	MOD:LVD: + LM PARAM	LVD 1 Trip
•	•	•	LVD 1 Reset
•	•	•	LVD 2 Trip
•	•	•	LVD 2 Reset
MX28B200/400 + ES BATT PIN OEM	BAT: + SET-ALM PARAM C	Batt Disc Thr	
•	•	Batt Disc Alm	
•	•	Batt HV Thr	
•	•	Batt HV Alm	
•	•	Batt LV Thr	
•	•	Batt LV Alm	
•	•	Batt HT Thr	
•	•	Batt HT Alm	
•	•	Batt LT Thr	
•	•	Batt LT Alm	
•	BAT: + LM PARAM COMP	Batt Float	

Top Level	Second Level	Third Level	Fourth Level
•	•	Batt Max Rech	
•	BAT: + AM COMP	Comp Method	
•	•	Comp TC	
•	•	Comp HKnee	
•	•	Comp LKnee	
MX28B200/400 + ES BATT PIN OEM	PIN		
MX28B200/400 + TT PIN OEM	OEM R Offset		
•	OEM R Gain		
•	OEM S Offset		
•	OEM S Gain		

Front Panel LED Indicators

Major (Red)	On when Major Relay is de-energized*
Minor (Yellow)	On when Minor Relay is energized
Normal (Green)	On when no alarms are active
ALM 1 (Red)	On when Output Relay 1 is energized
ALM 2 (Red)	On when Output Relay 2 is energized
ALM 3 (Red)	On when Output Relay 3 is energized
ALM 4 (Red)	On when Output Relay 4 is energized
ALM 5 (Red)	On when Output Relay 5 is energized
ALM 6 (Red)	On when Output Relay 6 is energized
MIN (Red)	On when Minor Relay is energized
MAJ (Red)	On when Major Relay is de-energized*

* This will produce a major relay output even when all power is lost.

4.7. Alarm Outputs (Output Relays)

There are eight alarm output relays designated Relay 1 through Relay 6, Minor, and Major, respectively. Various system parameters may be programmed to activate any of these alarm relays when set thresholds are exceeded or specific conditions occur. The first six relays can also be assigned a priority and routed or "mapped" to other output alarm relays. Available assignments are "Ignore", "Major", "Minor", and "Relay 1" ··· "Relay 6". Screens for making these assignments are located at **[SYSTEM/OUT-RLY/RLY-MAP]**. This feature makes it possible for a single alarm condition to activate multiple alarm output relays including the Minor or Major alarm relay. A user defined name or "alias" may also be assigned to each of the eight output relay alarms. Screens for making these assignments are located at **[SYSTEM/OUT-RLY/ALIAS]**. For information on making wiring connections to the alarm output relays refer to **Section 3.9**

4.8. External Alarm Inputs (Input Relays)

The controller can monitor any external device that uses a switch or relay to output status information. Connecting the external device to the input relay connections is the first step. The four external alarm inputs (also referred to as "Input Relay Alarms") can be assigned a priority and routed or "mapped" to alarm output relays. Available assignments are "Ignore", "Major", "Minor", and "Relay 1" ··· "Relay 6" (do not map relay to itself or the alarm will never clear). Screens for making the assignments are located at **[SYSTEM/IN-RLY/RLY-MAP]**. A user defined name or "alias" may also be assigned to each of these input alarms. Screens for making these assignments are located at **[SYSTEM/IN-RLY/ALIAS]**. For information on wiring connections to these inputs refer to **Section 3.10**

5 Remote Monitoring

5.1. Description

Remote monitoring and control of the DC power system is accomplished through the use of the optional APC Network Management card. This card is a separate module mounted into the top panel of the system controller module.

Complete documentation for the use of the management card accompanies the DC power system in the form of a small Quick Start Guide and a CD. The CD contains electronic copies of User's Manuals along with the necessary software utilities to support the management function.

5.2. Physical Connections

The management card has a RJ-45 connector to support a TCP/IP protocol over a 10BaseT Ethernet Local Area Network (LAN). The 9-pin D-shell connector uses the special RS-232 cable (APC part number 940-0024C) to allow local access through a Terminal Emulation program like HyperTerminal™ or Procomm™.(**)

5.3. Command and Monitoring Protocol

Refer to the User's Guides and associated documentation provided on the management card CD for the details on installation and use of the various communication protocols and command settings.

6 Specifications

The overall system specifications can vary, depending upon the number of rectifier modules. Note that some specification items are provided on a “per rectifier” basis and must be combined or totaled for a give system configuration.

6.1. AC Input

1MRF28H54BV Rectifiers

Nominal Input Voltage	208, 230 VAC
Input Voltage Range	176 – 264 VAC
AC Frequency Range	45 – 65 Hz
Apparent Power Factor	99% Typical, 98% Minimum
Maximum Input Current (per Rectifier)	13.9 Amps @ 230V AC

1MRF28H54BV50 Rectifiers

Nominal Input Voltage	277 VAC
Input Voltage Range	195 – 264 VAC
AC Frequency Range	45 – 65 Hz
Apparent Power Factor	99% Typical, 98% Minimum
Maximum Input Current (per Rectifier)	11.0 Amps @ 277V AC

6.2. DC Output (with either 1MRF28H54BV Rectifiers and 1MRF28H54BV50 Rectifiers)

Nominal Output Voltage (factory set)	54.5 VDC (**)
Operating Voltage Range	44 – 58 VDC (**)
Rated Output Current (per Rectifier)	50 A

Rated Output Power (per Rectifier)	2800 W (45ºC)
Efficiency	91% Typical

6.3. Controls and Indicators

Rectifiers

Input Healthy LED	AC power present.
Output Healthy LED	DC output voltage within operating range (-39.5 to –59.5 VDC).
Output Current LED	On when rectifier is supplying current.
Thermal Control LED	On when one of three internal sensors is above 90ºC
Current Limit LED	On when rectifier is in current limit. .
Overvolts LED	On when rectifier is above 57 Volts. (Must be powered down to reset)
Overtemp LED	On when one of three internal sensors is above 130ºC. Power Conversion is inhibited.
Fan fail LED	On when Fan is running too slow.
Standby LED	On when the unit is in the standby mode. No output power is produced. Rectifier is still active
+V Test Point	Rectifier Voltage can be measured with a voltmeter between COM and +V.
COM Test Point	Negative reference for both +V and +I
+I Test Point	Rectifier Current can be measured with a voltmeter between COM and +I.
Float / Boost/Equalize Switch	Used to Control voltage on systems without a PSCU
Float Trim Pot	The float pot is used to adjust the default float

	voltage (54.5 VDC).
Boost/Equalize Trim Pot	The boost/equalize pot is used to adjust the default boost equalize voltage (57.5 VDC).

6.4. Controls and Indicators

Power Shelf Control Unit

Major (Red)	On when Major Relay is de-energized*
Minor (Yellow)	On when Minor Relay is energized
Normal (Green)	On when no alarms are active
ALM 1 (Red)	On when Output Relay 1 is energized
ALM 2 (Red)	On when Output Relay 2 is energized
ALM 3 (Red)	On when Output Relay 3 is energized
ALM 4 (Red)	On when Output Relay 4 is energized
ALM 5 (Red)	On when Output Relay 5 is energized
ALM 6 (Red)	On when Output Relay 6 is energized
MIN (Red)	On when Minor Relay is energized
MAJ (Red)	On when Major Relay is de-energized*

6.5. Mechanical

Dimensions	15.75” high x 23” wide x 17.5” deep (MX28B-200) 22.75” high x 23” wide x 17.5” deep (MX28B-400)	
Weight	Housing	85 lbs. (MX28B-200) 110 lbs. (MX28B-400)
	Rectifier (each)	11 lbs
Color	Dawn Gray	

Mounting	Both front mounting on standard 23-inch rails and optional wall mounting are available.

6.6. Environmental

Ambient Temperature	(Operating)	-45ºC to +55ºC (+65ºC with reduced power output)
	(Storage)	-45ºC to +85ºC
Humidity	(Operating)	0 – 85% RH (non-condensing)
	(Storage)	0 – 95% RH (non-condensing)
Altitude	(Operating)	3000 m (9840 ft.)
	(Storage)	10000 m (39370 ft.)

6.7. Compliance

NEBS	Level 3 (pending)
Safety	UL 1950
EMC	FCC Part 15 Class B

7 APC Worldwide Customer Support

Customer Support for this or any other APC product is available at no charge. You can contact APC Customer Support in any of the following ways:

- Use an APC web page to find answers to frequently asked questions (FAQs), to access documents in the APC Knowledge Base, and to submit customer support requests.
 - http://www.apc.com (Corporate Headquarters)
 Connect by links to APC web pages for specific countries and regions, each of which provides customer support information.
 - http://www.apc.com/support/
 Submit customer support requests.

- Contact Local or regional APC Customer Support by telephone or e-mail.
 - For e-mail addresses and local, country-specific, customer support telephone numbers worldwide, refer to: http://www.apc.com/support/contact.
 - For e-mail addresses and technical support telephone number of major APC regional customer support centers, use the following list:

APC Headquarters (US and Canada)	(1)(800) 800-4272 (1-800-800-4APC)
Latin America	(1)(401) 789-5735 (US) apctchla@apcc.com
Europe, Middle East, Africa	(353)(91)702020 (Ireland) apceurtech@apcc.com
Japan	(03) 5434-2021 jsupport@apcc.com

- Contact the APC representative or other distributor from whom you purchased your APC hardware device or APC software application for information on how to obtain local customer support.

8 Warranty

General Provisions

APC DC Network Solutions Inc. warrants the power equipment and components it manufactures or sells against defective materials and workmanship for a period of TWO (2) YEARS from the date of shipment.

Warranty Returns

If initial physical inspection results in identification of a material or workmanship flaw(s) that could impair product performance as defined by APC 's electrical and physical specification in effect at the time of shipment, and if this flaw(s) is not due to transportation damage or installation abuse, contact APC DC Network Solutions Inc. or call the 24-hour emergency number, (800) 800 4APC, to request assistance
.
You will be provided either a) an RMA number with instructions for return of the equipment or component(s) to the APC DC Network Solutions Inc. factory service center, FOB destination, freight pre-paid, for examination, or b) for non-returnable systems and equipment, notice to wait until an APC DC Network Solutions Inc. authorized service representative arrives at the site to inspect the equipment. Repaired or advance replacement modules or circuit components will normally be available within 24 to 48 hours of receipt of equipment or RMA.

Warranty Repair or Replacement

If, during the warranty period, the supplied equipment is found to be physically or electrically faulty due to defective materials or workmanship on the part of APC DC Network Solutions Inc., the defective product(s) or component(s) will be repaired or replaced at the sole option of APC DC Network Solutions Inc. without charge to the user for replacement materials or repair labor. (The procedure outlined above for contacting APC DC Network Solutions Inc. must be followed.) Costs incurred for replacement installation including, but not limited to, installation equipment, travel expenses of an APC DC Network Solutions Inc. representative(s), and costs of installation material transportation expenses are not the responsibility of APC DC Network Solutions Inc. Any replacement product(s) or component(s) shall only complete the remaining unused portion of the original warranty of the replaced product(s) or component(s)

Exclusions and Limitations

1. This warranty applies only to the original US domestic purchaser (user) and is not transferable internationally, except with expressed written consent from APC DC Network Solutions Inc. headquarters in Dallas, Texas.

2. APC DC Network Solutions Inc. reserves the right to void the warranty if identification marks or serial numbers have been removed or tampered with, or the defect is determined to have been caused by misuse, neglect, improper installation, environmental conditions, non-authorized repair, alteration, or accident.

3. This warranty does not cover physical damage due to the acts of nature or man that stress the equipment or component(s) beyond design limits and exert undesirable influence aside from normal wear and tear.

4. APC DC Network Solutions Inc. assumes no responsibility for any work accomplished or expenses incurred except with expressed written consent from APC DC Network Solutions Inc.

5. APC DC Network Solutions Inc. shall not be liable to the user (purchaser) or any third party for indirect, incidental, or consequential damages such as, but not limited to, loss of use, loss of profits, costs associated with removal/installation of a defective product(s) or component(s) arising out of the sale or relating to the use of this product, and the user (purchaser) assumes responsibility for all personal injury and property damage resulting from the handling, possession, or use of the product. In no event shall the liability of APC DC Network Solutions Inc. for any and all claims, including claims of breach of warranty or negligence, exceed the purchase price of the product that gave rise to the claim.

The above warranty is in lieu of all other remedies, including actions for contract or negligence.

All other warranties, expressed or implied, including but not limited to the implied warranties of merchantability and fitness for a particular purpose, are hereby excluded